GOES-R Proving Ground

2010 Update

Presented by Jim Gurka

NOAA/NESDIS/GOES-R Program Office

May 5, 2010

2nd NOAA Testbed Workshop, Boulder CO

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Outline

- What is the GOES-R Proving Ground?
- PG Program Plan
- Examples of GOES-R Proxy Products at:
  - Cooperative Institutes
  - SPC Spring Experiment
  - NHC 2010 Hurricane Season
- Summary

GOES-R Proving Ground

– What is the GOES-R Proving Ground?

  - Collaborative effort between the GOES-R Program Office, selected NOAA/ NASA Cooperative Institutes, NWS forecast offices, NCEP National Centers, and NOAA Testbeds.

  - Where proxy and simulated GOES-R products are tested, evaluated and integrated into operations before the GOES-R launch

  - A key element of GOES-R User Readiness (Risk Mitigation)

Proving Ground Mission Statement

The GOES-R Proving Ground engages NWS in pre-operational demonstrations of selected capabilities of next generation GOES

- Objective is to bridge the gap between research and operations by:
  - Utilizing current systems (satellite, terrestrial, or model/synthetic) to emulate future GOES-R capabilities
  - Infusing GOES-R products and techniques into NWS operations with emphasis on AWIPS and transitioning to AWIPS-II.
  - Engaging in a dialogue to provide feedback to developers from users

- The Proving Ground accomplishes its mission through:
  - Sustained interaction between developers and end users for training, product evaluation, and solicitation of user feedback.
  - Close coordination with GOES-R Algorithm Working Group (AWG) and Risk Reduction programs as sources of demonstration products, promoting a smooth transition to operations

Intended outcomes are Day-1 readiness and maximum utilization for both the developers and users of GOES-R products, and an effective transition to operations

PG Program Plan

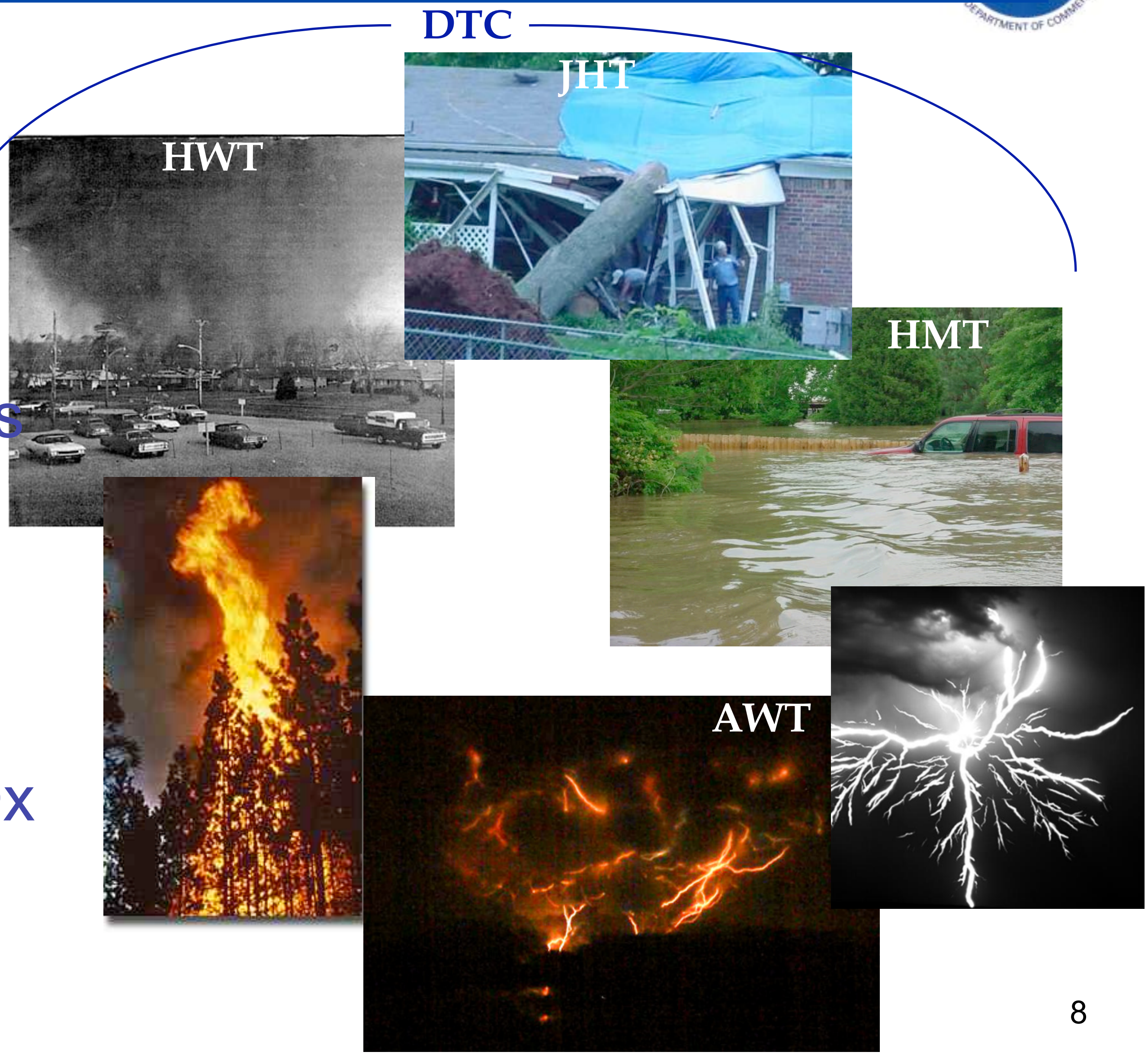
- Program Plan Published in Feb. 2010
  - www.goes-r.gov
- Provides framework and guiding principles for PG to provide early use of GOES-R capabilities
- Purpose of plan:
  - Document vision and objectives of PG Program and concepts
  - Describe overall scope and management approach
  - Identify key decision points and checkpoints for effective management control

PG Program Plan

- Participants: The intent is that the PG activities be conducted at many and varied field sites including NOAA Test Beds and numerous WFOs in all NWS Regions. The NOAA Testbeds include:
  - Hazardous Weather Testbed
  - Hydrometeorological Testbed
  - Aviation Weather Testbed
  - Joint Hurricane Testbed
  - Developmental Testbed Center

Natural Hazards and Lightning

- Tornadoes
- Hailstorms
- Wind
- Thunderstorms
- Floods
- Hurricanes
- Volcanoes
- Forest Fires
- Air Quality/NOx



GOES-R Proving Ground Partners

75 Total Partners Preparing

Current as of December 2009

NOAA/NWS Headquarters (Silver Spring, MD); Center for Satellite Applications and Research; Office of Satellite Data Processing and Distribution.

GOES-R Program Office (Greenbelt, MD).

- Yellow: ***3*** Weather Service Offices served by the Cooperative Institute for Research in the Atmosphere (CIRA)
- White: ***4*** Weather Service Offices served by the Cooperative Institute for Climate and Satellites (CICS) via SPoRT
- Magenta: ***11*** National/Regional
- Cyan: ***15*** Weather Service Offices served by the NASA Short-term Prediction Research and Transition Center (SPoRT)
- Red: ***46*** Weather Service Offices served by the Cooperative Institute for Meteorological Satellite Studies (CIMSS)

GOES-R Proving Ground Partners

75 Total Partners Preparing

Current as of December 2009

46 Weather Service Offices served by the Cooperative Institute for Meteorological Satellite Studies (CIMSS)

- Aberdeen, South Dakota (ABR)
- Amarillo, Texas (AMA)
- Billings, Montana (BYZ)
- Binghamton, New York (BGM)
- Boulder, Colorado (BOU)
- Burlington, Vermont (BTV)
- Charleston, South Carolina (CHS)
- Chicago, Illinois (LOT)
- Columbia, South Carolina (CAE)
- Dallas/Fort Worth, Texas (FWD)
- Davenport, Iowa (DVN)
- Des Moines, Iowa (DMX)
- Duluth, Minnesota (DLH)
- El Paso, Texas (EPZ)
- Fargo, North Dakota (FGF)
- Glasgow, Montana (GGW)
- Green Bay, Wisconsin (GRB)
- Greenville, South Carolina (GSP)
- Indianapolis, Indiana (IND)
- Jackson, Kentucky (JKL)
- Juneau, Alaska (AJK)
- Kansas City, Missouri (EAX)
- La Crosse, Wisconsin (ARX)
- Las Vegas, Nevada (VEF)
- Marquette, Michigan (MQT)
- Medford, Oregon (MFR)
- Midland, Texas (MAF)
- Milwaukee, Wisconsin (MKX)
- Minneapolis, Minnesota (MPX)
- Monterey, California (MTR)
- Nashville, Tennessee (OHX)
- Norman, Oklahoma (OUN)
- Northern Indiana (IWX)
- Pendleton, Oregon (PDT)
- Pittsburgh, Pennsylvania (PBZ)
- Raleigh, North Carolina (RAH)
- Rapid City, South Dakota (UNR)
- Reno, Nevada (REV)
- Riverton, Wyoming (RIW)
- Spokane, Washington (OTX)
- Springfield, Missouri (SGF)
- State College, Pennsylvania (CTP)
- Sterling, Virginia (LWX)
- Tulsa, Oklahoma (TSA)
- Wichita, Kansas (ICT)
- Spaceflight Meteorology Group (SMG)

Univ. of Maryland, Baltimore, Co.

- State/Local/Tribal Air Quality Forecast Offices (non-NOAA)

UMBC AN HONORS UNIVERSITY IN MARYLAND

3 Weather Service Offices served by the Cooperative Institute for Research in the Atmosphere (CIRA)

- Boulder, Colorado (BOU)
- Cheyenne, Wyoming (CYS)
- Eureka, California (EKA)

15 Weather Service Offices served by the NASA Short-term Prediction Research and Transition Center (SPoRT)

- Albuquerque, New Mexico (ABQ)
- Birmingham, Alabama (BMX)
- Corpus Christi, Texas (CRP)
- Great Falls, Montana (TFX)
- Houston, Texas (HGX)
- Huntsville, Alabama (HUN)
- Key West WFO (KEY)
- Melbourne, Florida (MLB)
- Miami, Florida (MFL)
- Mobile, Alabama (MOB)
- Morristown, Tennessee (MRX)
- Nashville, Tennessee (OHX)
- Peachtree City WFO (FFC)
- Spaceflight Meteorology Group (SMG)
- Tallahassee, Florida (TAE)

4 Weather Service Offices served by the Cooperative Institute for Climate and Satellites (CICS) via SPoRT

- Blacksburg Virginia (RNK)
- Raleigh, North Carolina (RAH)
- Sterling, Virginia (LWX)
- Wakefield, Virginia (AKQ)

11 National and Regional Centers

- Alaska, Anchorage (ARH)
  - Anchorage and Fairbanks
- Eastern, Bohemia, New York (ERH)
- Central, Kansas City, Missouri (CRH)
- Pacific, Honolulu, Hawaii (PRH)
- Southern, Fort Worth, Texas (SRH)
- Western, Salt Lake City, Utah (WRH)
- Aviation Weather, Kansas City (AWC)
- Bonneville Power Administration (BPA)
- Environmental Protection Agency (EPA)
- National Hurricane Center, Miami (NHC)
- Storm Prediction Center, Norman (SPC)

GOES-R Warning Product Set

The following list is of products offers opportunity for near-real time Warning Related utility.

<u>Baseline Products:</u>
Volcanic Ash: detection & Height
Cloud and Moisture Imagery
Hurricane Intensity
Lightning Detection: Events, Groups & Flashes
Rainfall Rate / QPE
Total Precipitable Water
Fire/Hot Spot Characterization

<u>Option 2 Products:</u>
Aircraft Icing Threat
Convective Initiation
Enhanced “V” / Overshooting Top Detection
Low Cloud and Fog
SO_2 Detection

SPC Spring Experiment

- In 2009 experiment…primary focus was on Convective Initiation Product.
- In 2009 experiment…LMA data used to generate 10-km source density product from three sites:
  - Norman OK
  - Huntsville AL
  - Washington D.C.

SPC Spring Experiment

- In 2010 experiment…Products to be evaluated include:
  - Convective Initiation (CI)
  - Lightning Detection
  - Enhanced V/ Overshooting Top Detection
  - Cloud and Moisture Imagery
  - CIMSS “Nearcasting” model (risk reduction)
  - CIRA Hail Probability (risk reduction)
- In 2010…. More robust GLM proxy data set
  - Total flash density product at 8 km resolution
  - More accurate simulation of future GLM products
  - May be provided to SPC operations
  - Data from additional sites will be provided to support SPC

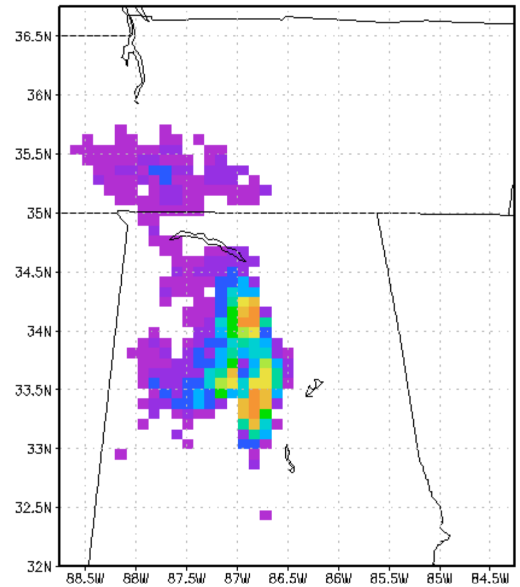
SPoRT Pseudo GLM Product

Provide forecaster exposure to GLM data, differences from LMA, applicability to severe weather forecasting – benefits transition of full AWG proxy when available

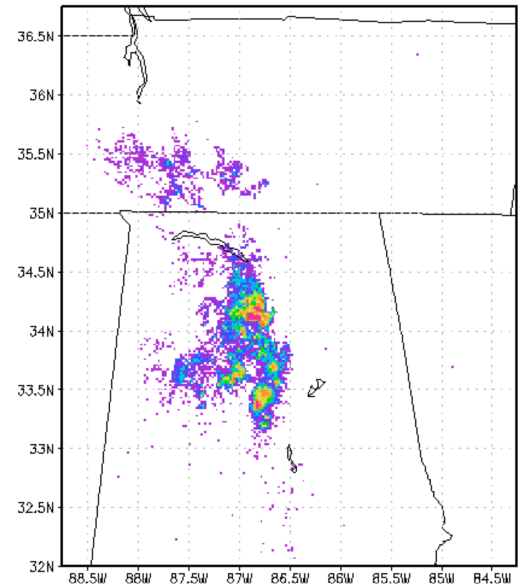
Flash Extent Density derived from LMA data at GLM resolution

- different from AWG proxy - no optical data
- forecaster demonstration and education
- applicable to other total lightning networks
- focus on AWIPS II development with user feedback

Pseudo GLM Flash Extent

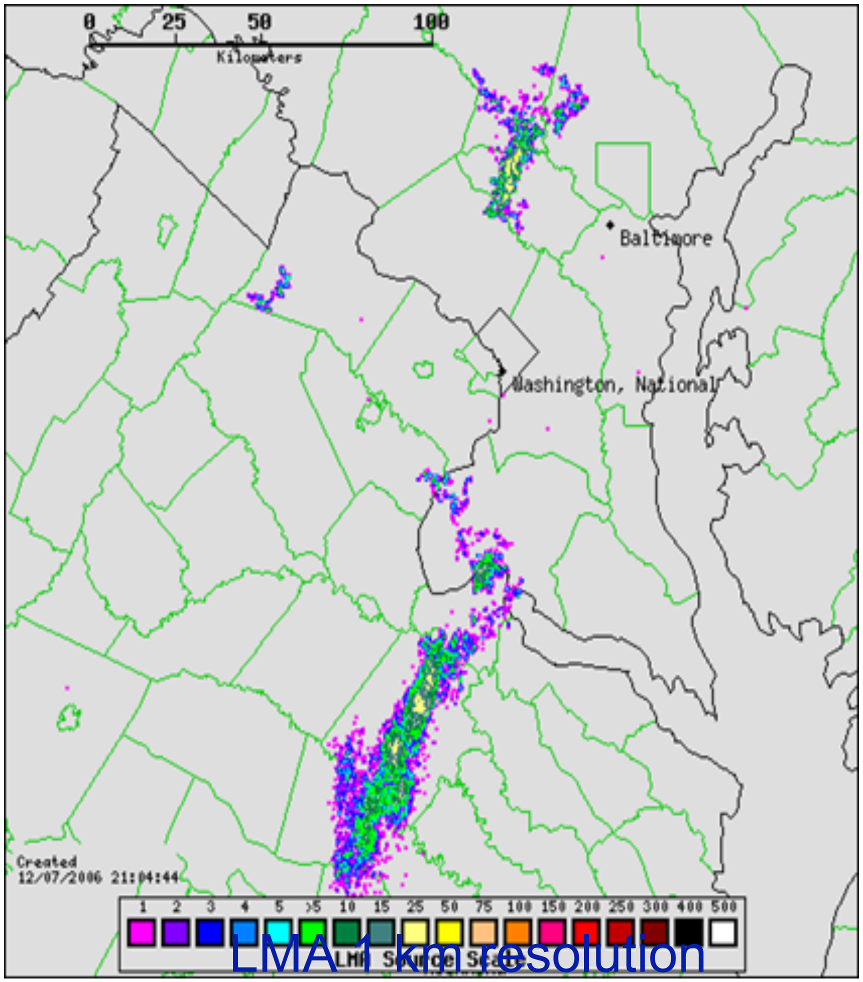


LMA Source Densities

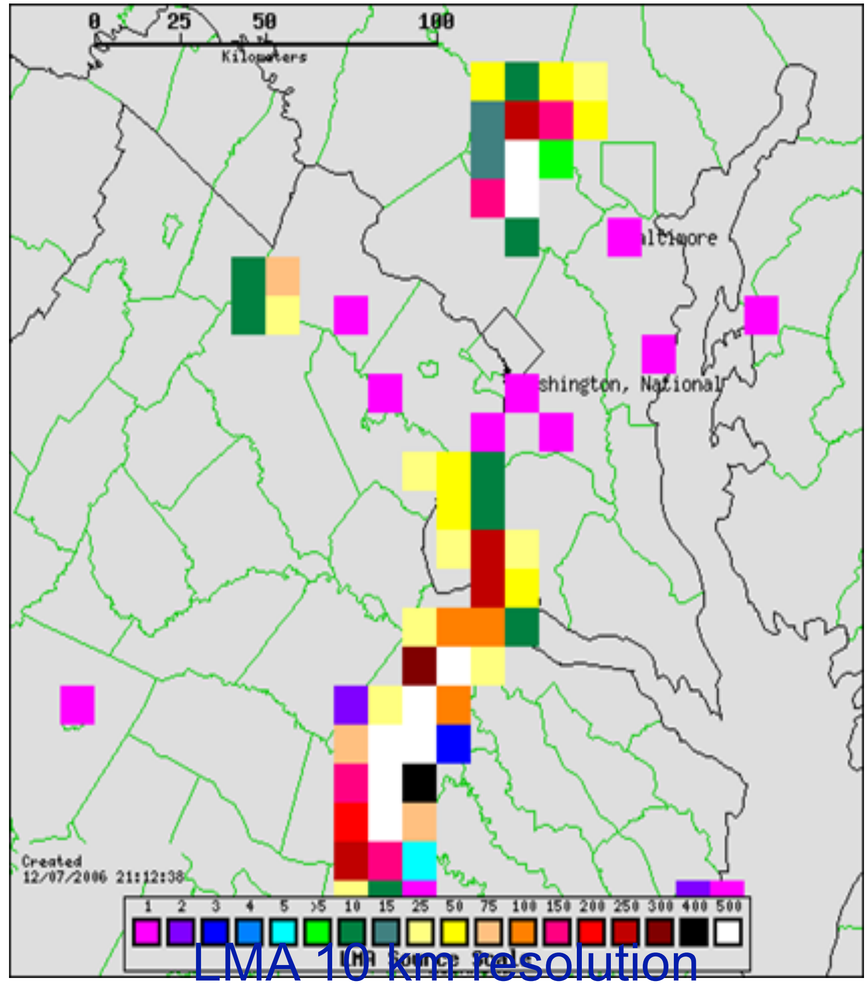


DC Regional Storms November 16, 2006

GLM Proxy: Resampled 5-min source density at 1 km and 10 km



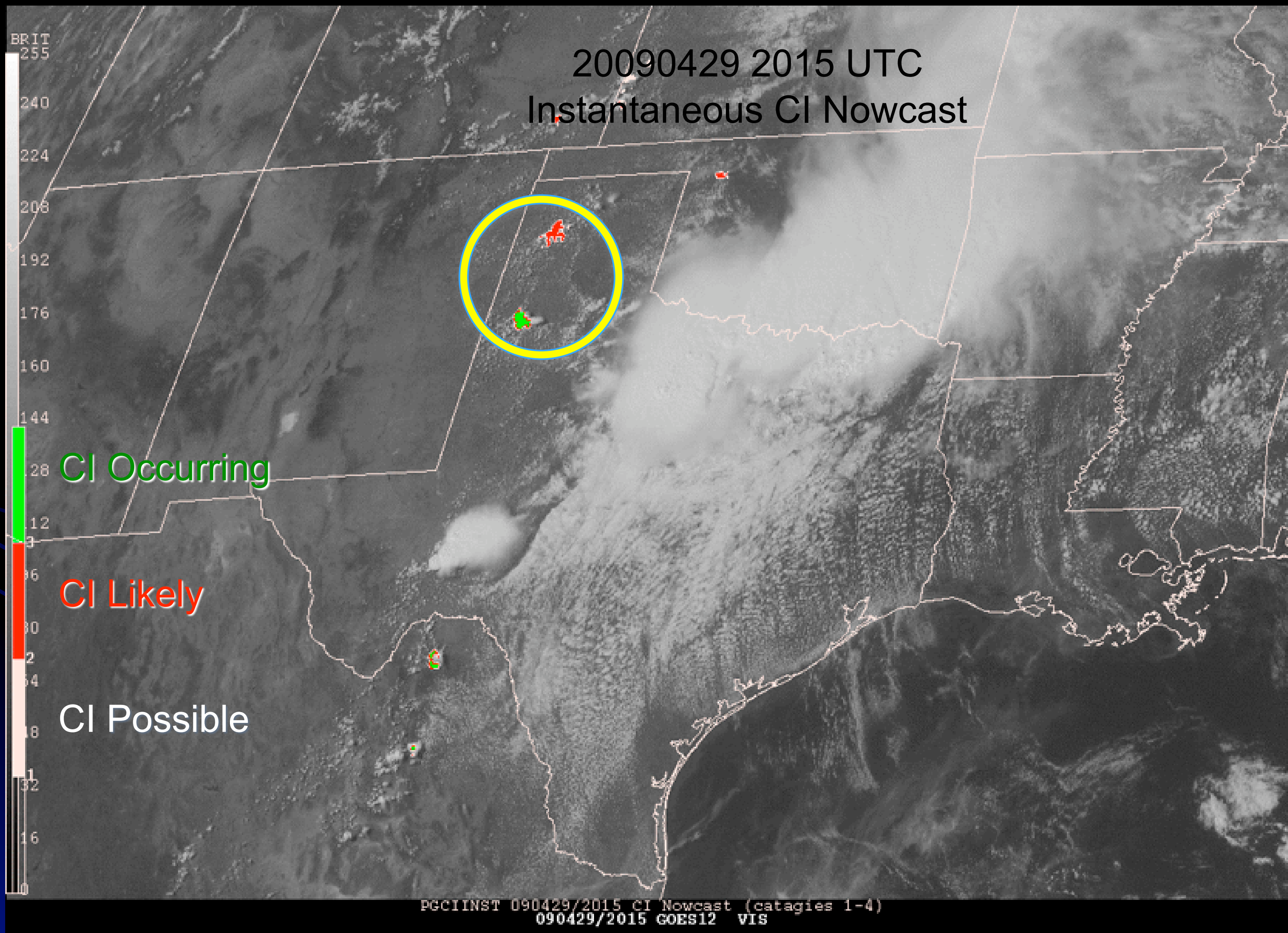
LMA 1 km resolution



LMA 10 km resolution

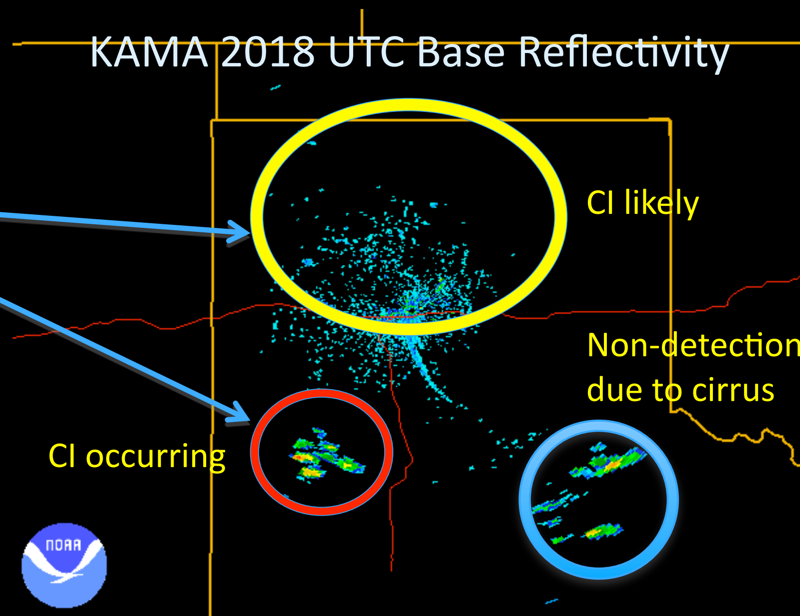
http://branch.nsstc.nasa.gov/PUBLIC/DCLMA/

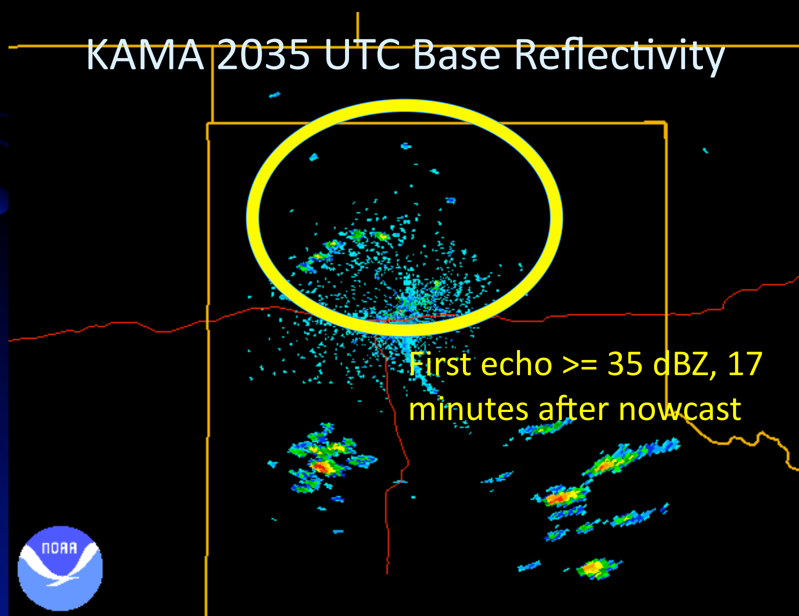
20090429 Dryline CI Case
SPC HWT Proving Ground

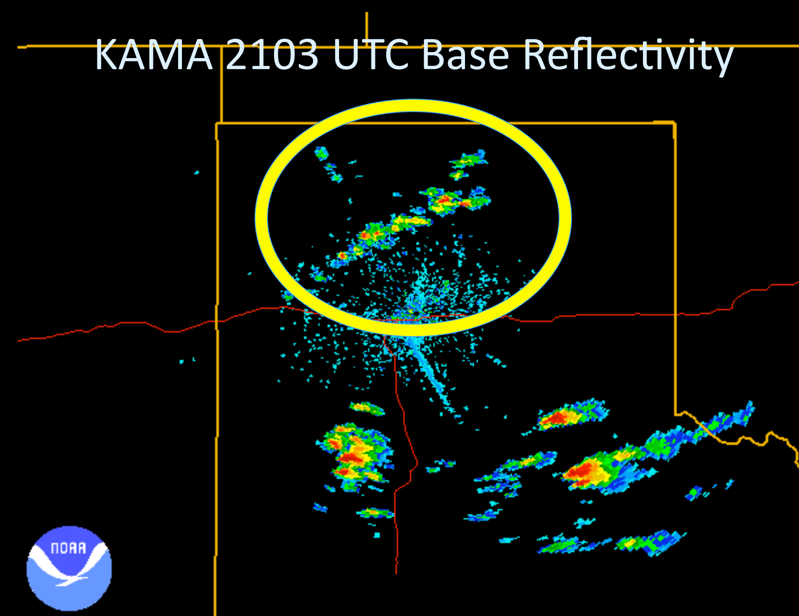


CI nowcast at 2015 UTC

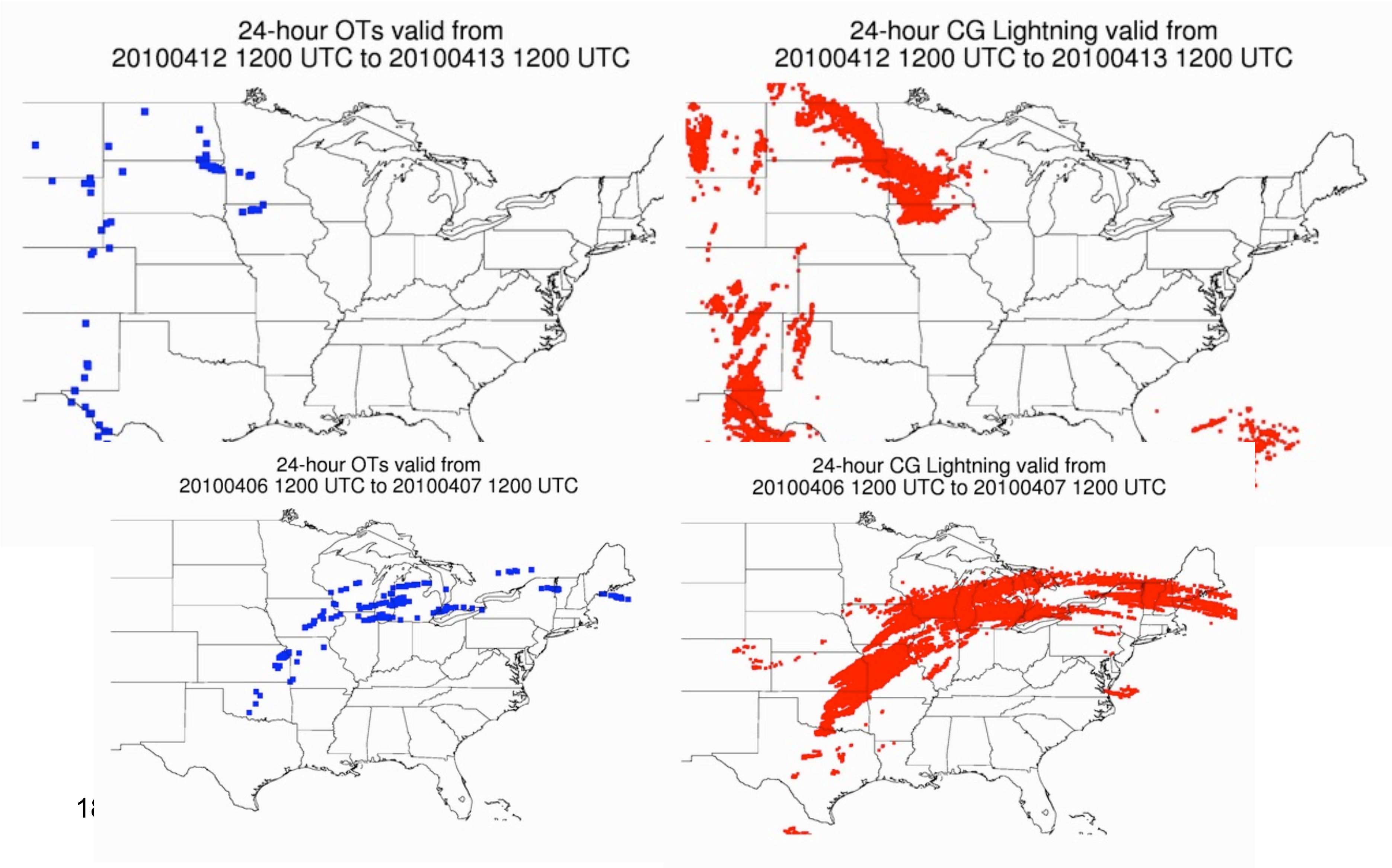
29 April 2009







OT Validation



Using the GOES-12 Sounder to Nearcast Severe Weather

Robert Aune (NESDIS) and Ralph Petersen (CIMSS)

The CIMSS Near-casting Model uses hourly GOES Sounder retrievals of layered precipitable water (PW) and equivalent potential temperature (Theta-E) to predict severe weather outbreaks up to *6 hours in advance!*

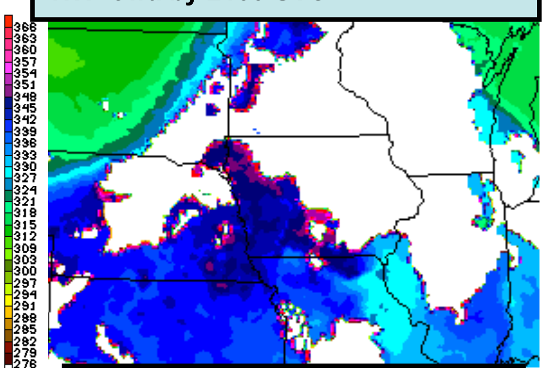
Hourly, multi-layered observations from the GOES Sounder are projected forward in time along Lagrangian trajectories forced by gradient winds. "Trajectory observations" from the previous six hours are retained in the analysis. Destabilization is indicated when theta-E decreases with height.

Limitations:

- **Sounder channels support only two layers for near-casting**
- **Only useful for elevated convection – Sounder can't detect low-level moisture**
- **Frequent false alarms – Sounder can't detect inversions**

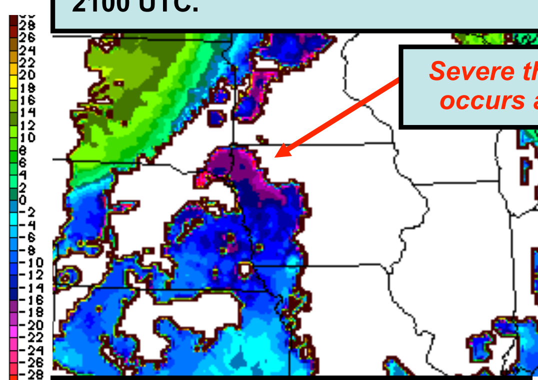
One Example of a Successful Near-cast

Low-level Theta-E NearCasts shows warm moist air band moving into far NW Iowa by 2100 UTC.



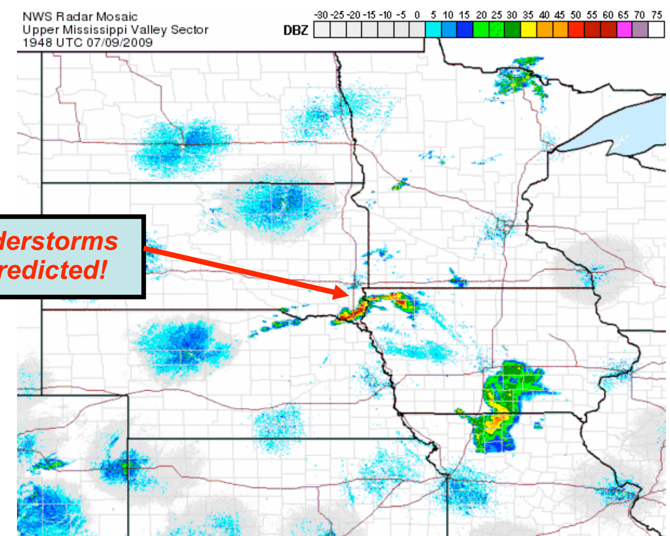
6-hour NearCast for 2100 UTC
Low level Theta-E

Vertical Theta-E Differences predict complete convective instability by 2100 UTC.



Severe thunderstorms occurs as predicted!

6-hour NearCast for 2100 UTC
Low to Mid level Theta-E Differences



Rapid Development of Convection over NW Iowa between 2000 and 2100 UTC 9 July 2009

NHC Proving Ground

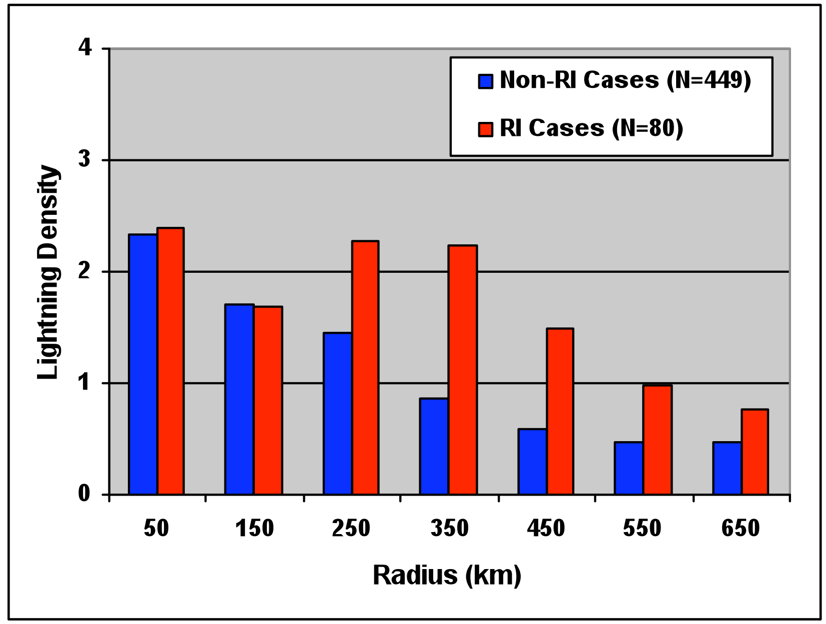
- Hurricane products for 2010 PG:
  - Hurricane intensity estimate (baseline)
  - Super rapid scan imagery (baseline)
  - RGB aerosol/ dust product
  - Saharan air layer (SAL)
  - Rapid intensification index
    - Based on Global Lightning Detection Network

NHC Proving Ground

- In 2010 Ground-based WWLLN will be used as a proxy for GLM in tropical cyclone studies
  - Crude adjustment applied to account for the low detection rate of WWLLN and conversion C-G to total lightning
  - Adjustment makes annual mean WWLLN density equal to that from the OTD/LIS climatology over Atlantic tropical cyclone basin.
- Storm-centered lightning density calculated and related to changes in tropical cyclone intensity
  - Results show that lightning density in the rain bands is related to subsequent intensity changes (if vertical shear accounted for)
- Algorithm to use lightning data in combination with global model fields to predict rapid intensity change under development

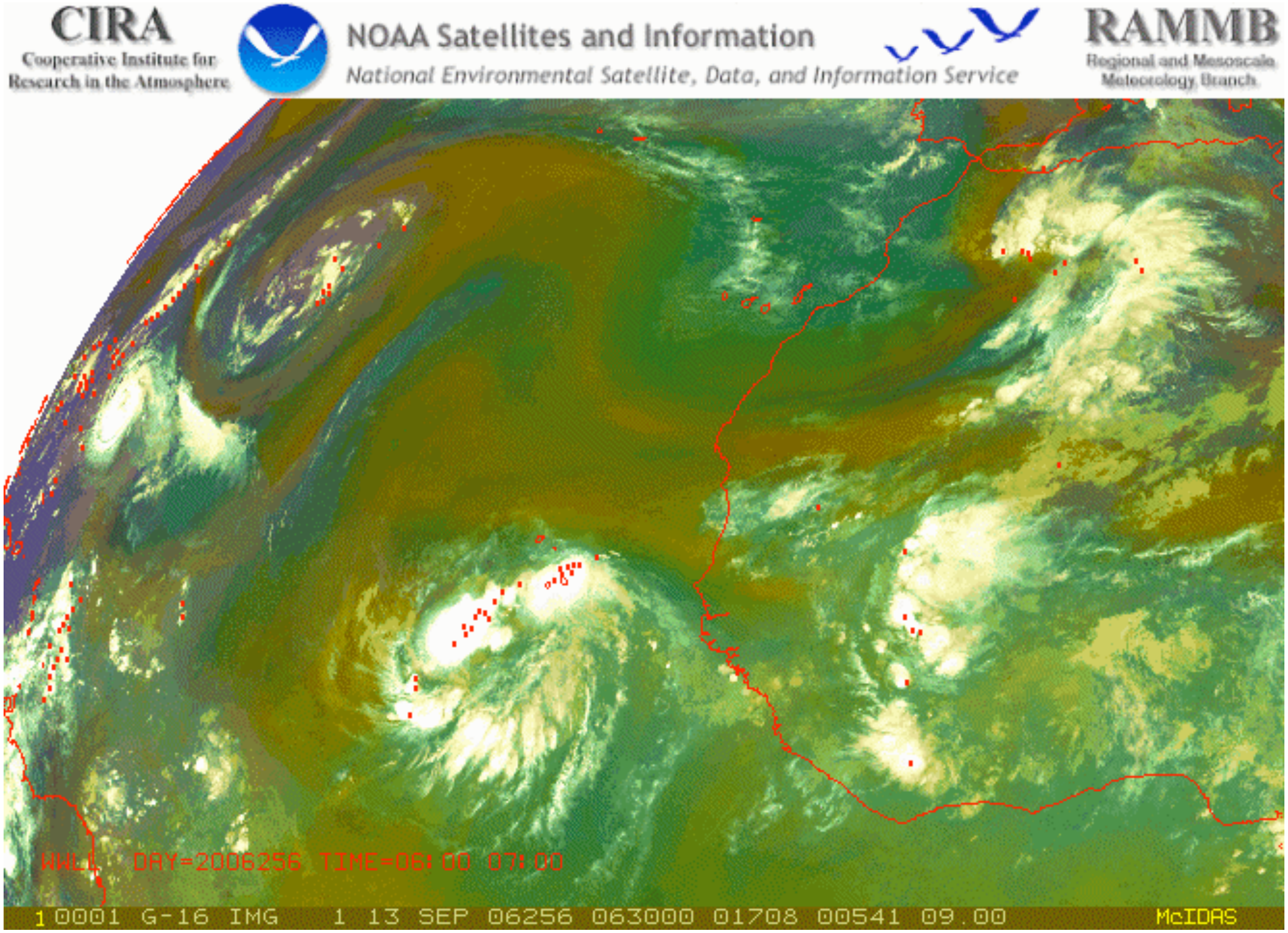
GLM Application to Tropical Cyclone Rapid Intensity Prediction

- WWLLN lightning data normalized to total lightning
- Combine lightning input with statistical input from SHIPS model
- Test in 2010 proving ground

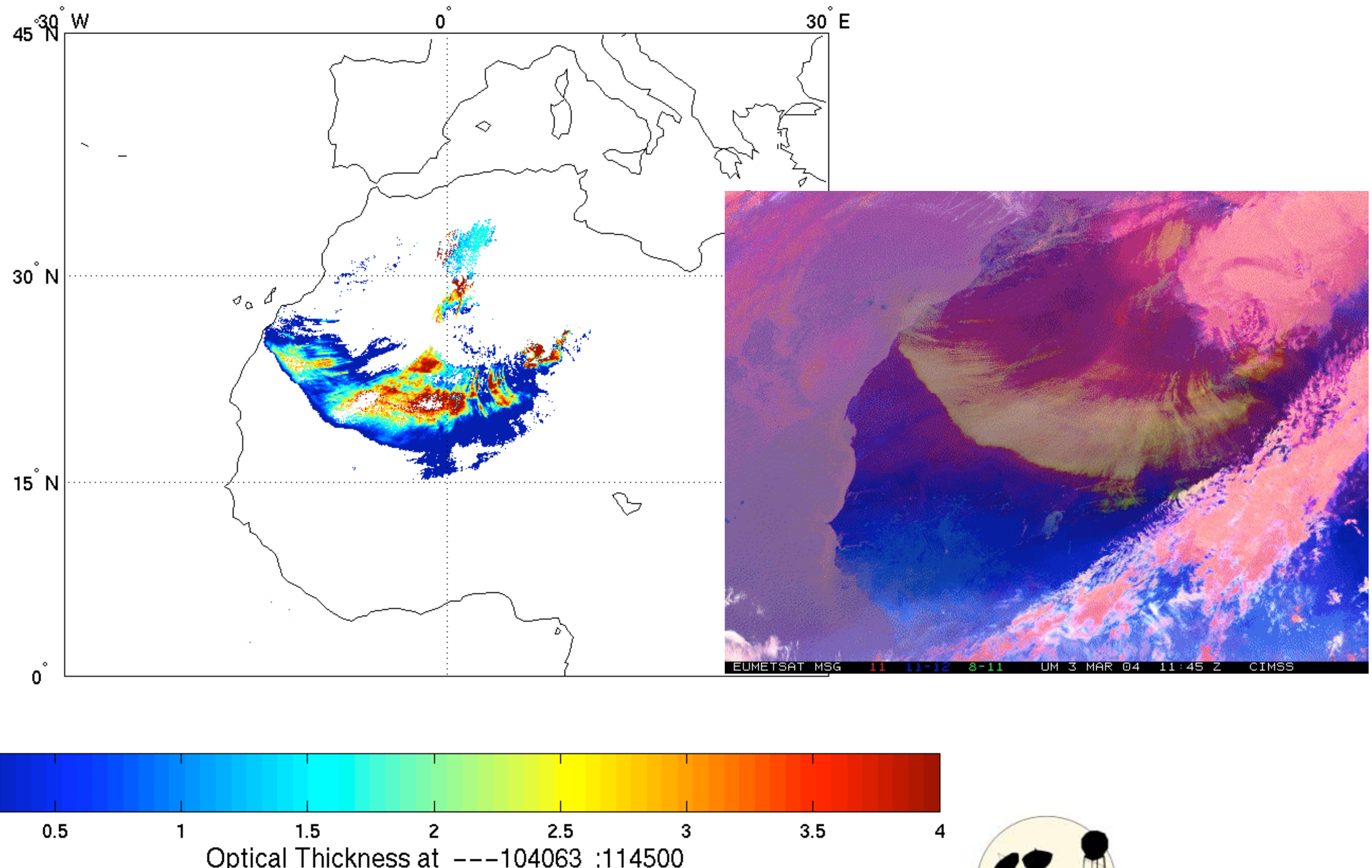


Caption: Lighting density in outer radii Good discriminator of rapid intensification Provided vertical shear is accounted for.

RGB Air Mass Product with Lightning



Aerosol/Dust Optical Thickness Retrieval Results from SEVIRI@EUMETSAT

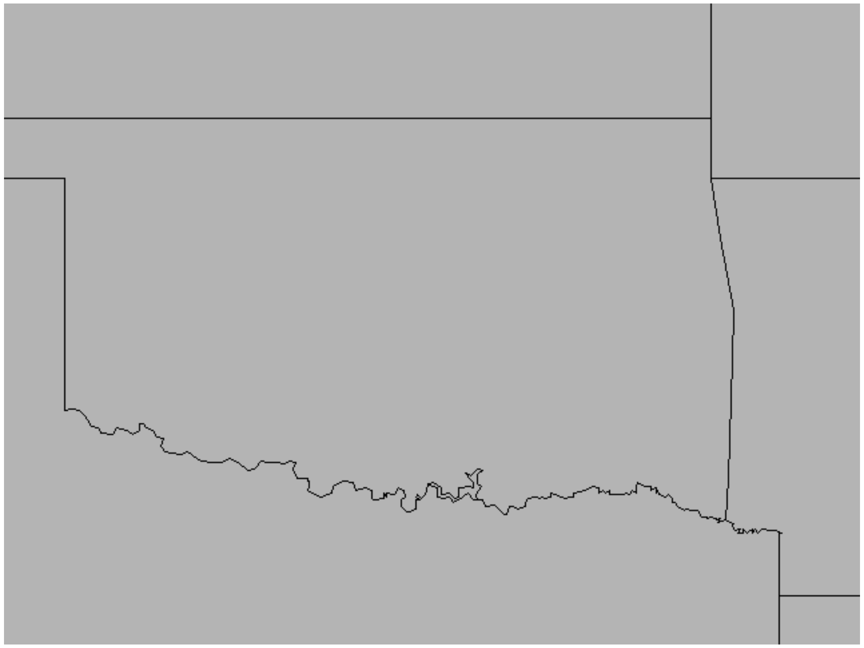


TRMM LIS-Lightning: May 1999 Stroud, OK Tornado

TRMM provides us a huge database of paired lightning, radar, IR and passive microwave observations (training, validation)

Over entire tropics & subtropics (generalization)

GOES-R GLM Perspective



1-min total lightning activity

Lessons Learned at SPC

- Convective Initiation (CI)/Cloud Top Cooling (CTC)
  - CTC is valuable product in itself
  - Diagnostic tool rather than prognostic over SE warm sector environments
  - Masked where thick cirrus present
  - Thin cirrus over land/water/water clouds and expanding edge false alarms
  - Avg. lead time ~15 minutes over radar (for successful nowcasts)
  - Full disk 30 min. scan limitations (false alarms/missed nowcasts)
  - Cloud detection limitations due to poor spatial/spectral resolution
  - Instantaneous fields more useful to forecasters than accumulated fields
  - Overlay on visible/IR essential to forecasters
  - Continue CTC after CI occurs (storm severity) interest from forecasters
  - Effective for terrain/dryline convection
  - CI misses some CTC signals
  - Works well in rapid scan operations

Summary

- GOES-R Proving Ground provides mechanism to:
  - Involve CIs, National Centers, NOAA Testbeds and WFOs in user readiness
  - Get prototype GOES-R products in hands of forecasters
  - Keep lines of communication open between developers and forecasters
  - Allow end user to have have say in final product, how it is displayed and integrated into operations
- For a GOES-R Success…Forecasters must be able to use GOES-R products on Day 1

Backup Slides

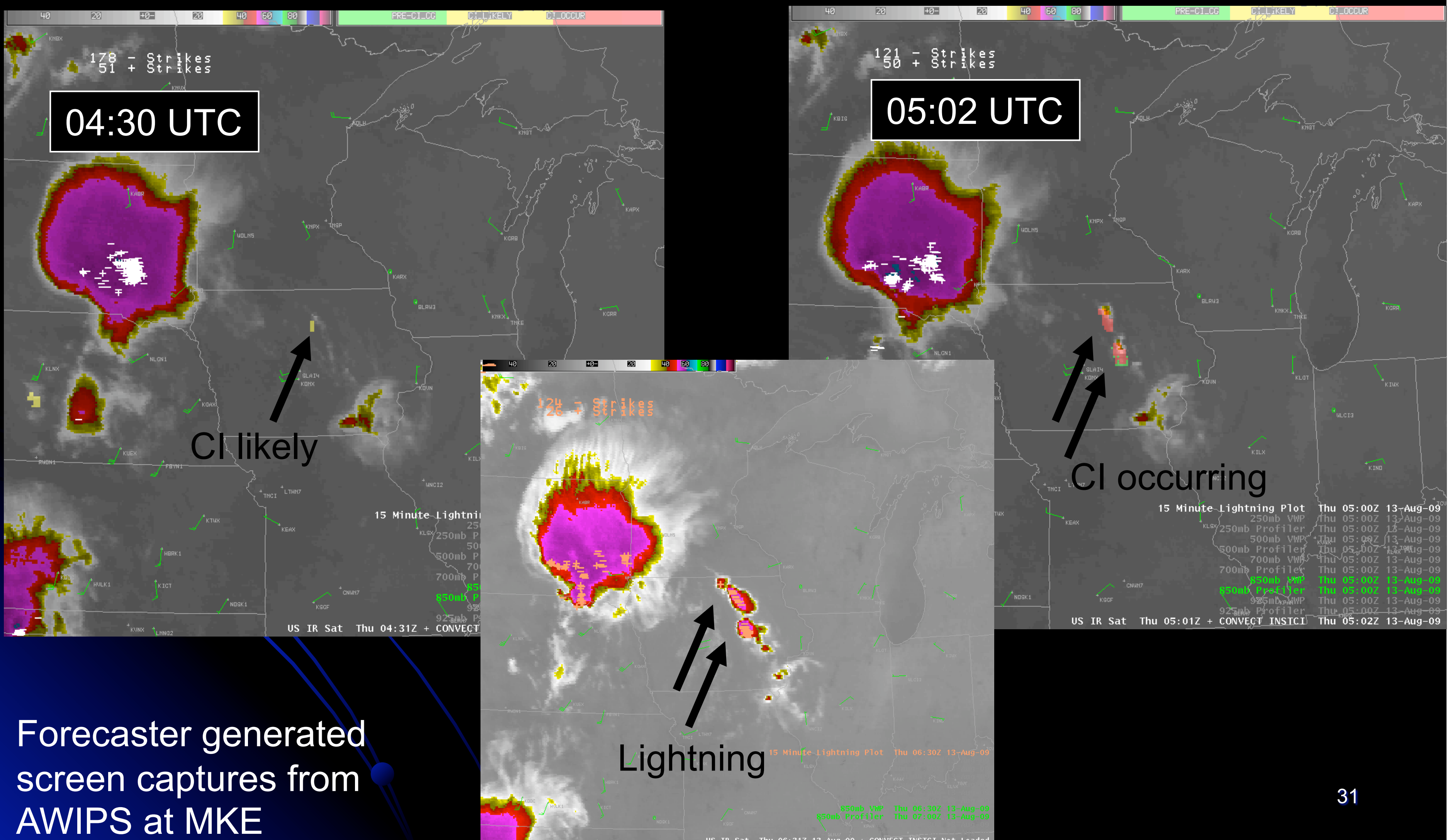
GOES-R Proving Ground

- Place where technologies and ideas are tested and proven before being fielded in operations
- Evaluates how infusion of technology or process in forecast environment impacts operations
- Integrates technology or process with other available tools
- User readiness risk mitigation
- Key component: operational testing by those independent of the development process
- Key Benefit: users more accepting of fielded technology
  - They have had a say in the design
  - Design better fits an identified need

ABI Capabilities to Aid Evaluation of Lightning Threat

- Detection of and rapid refresh trending of:
  - Cloud Top Temperature
  - Cloud Top Phase
  - Cloud Top Particle Size
  - Overshooting Tops
  - Boundary Locations (i.e. outflow boundaries, drylines, seabreeze fronts, differential heating boundaries etc)
  - Stability (Legacy Sounder Products)
  - Enhanced "V"
  - Convective Initiation Product
  - Cloud Mask
  - Integration of ABI Products With Other Data Sets

AWIPS CI/CTC Interaction with Sullivan (MKE) NWS Office



Forecaster generated screen captures from AWIPS at MKE

AWIPS CI/CTC Interaction with Sullivan (MKE) NWS Office

"The UWCI performed very well in Iowa last night! These thunderstorms fired up along an existing boundary and are coincident with the leading edge of 700mb moisture transport and weak 850mb warm air advection."

- Marcia Cronce NWS Forecaster

SPoRT GOES-R Proving Ground Activities

Collaborate with Algorithm Working Groups (AWGs) and Proving Ground (PG) teams to prepare forecasters for unique data and products coming from GOES-R sensors by:

- transitioning proxy and simulated products to the operational environment linking products to forecast problems
- develop appropriate product training for end user education
- conduct assessments of utility of products on improved forecast capabilities

SPoRT emphasis on:

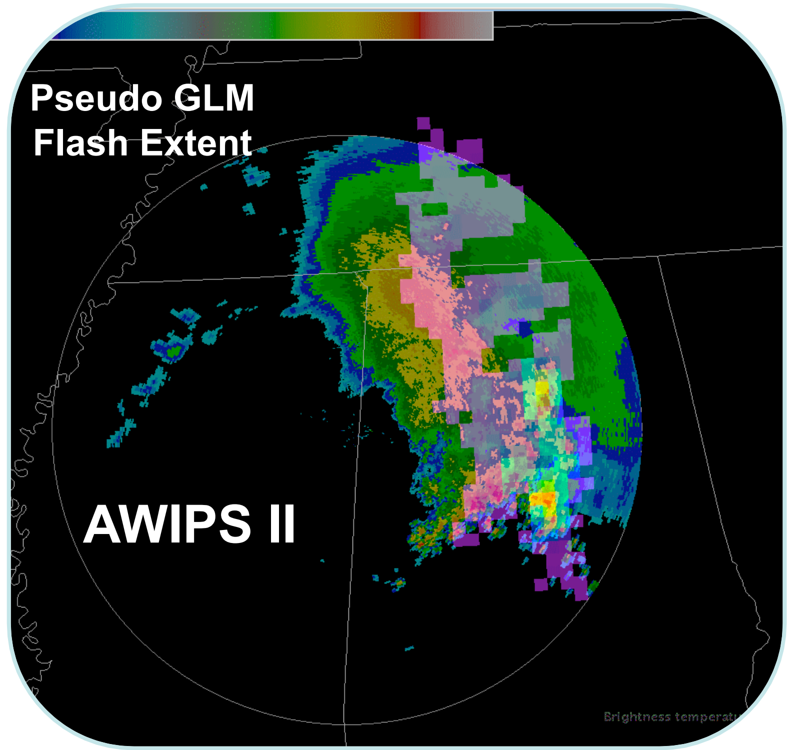
- high resolution proxy ABI products and multichannel combinations of image data – situational awareness
- pseudo GLM products – lightning warning and severe weather
- WRF-based lightning forecasts – lightning threat forecasts

Examples presented in following charts

SPoRT Pseudo GLM Product in AWIPS II

AWIPS II will allow for a more versatile ingest and display of total lightning data

- point data and imagery (as in AWIPS)
- Better control of display / values
- allow for the development of 3D displays
- greater interaction with other data sets



Radar reflectivity combined with pseudo GLM flash extent product in the AWIPS II environment

SPoRT

SPoRT is working collaboratively with AWGs and PG teams to prepare forecasters for unique data and products coming from GOES-R sensors

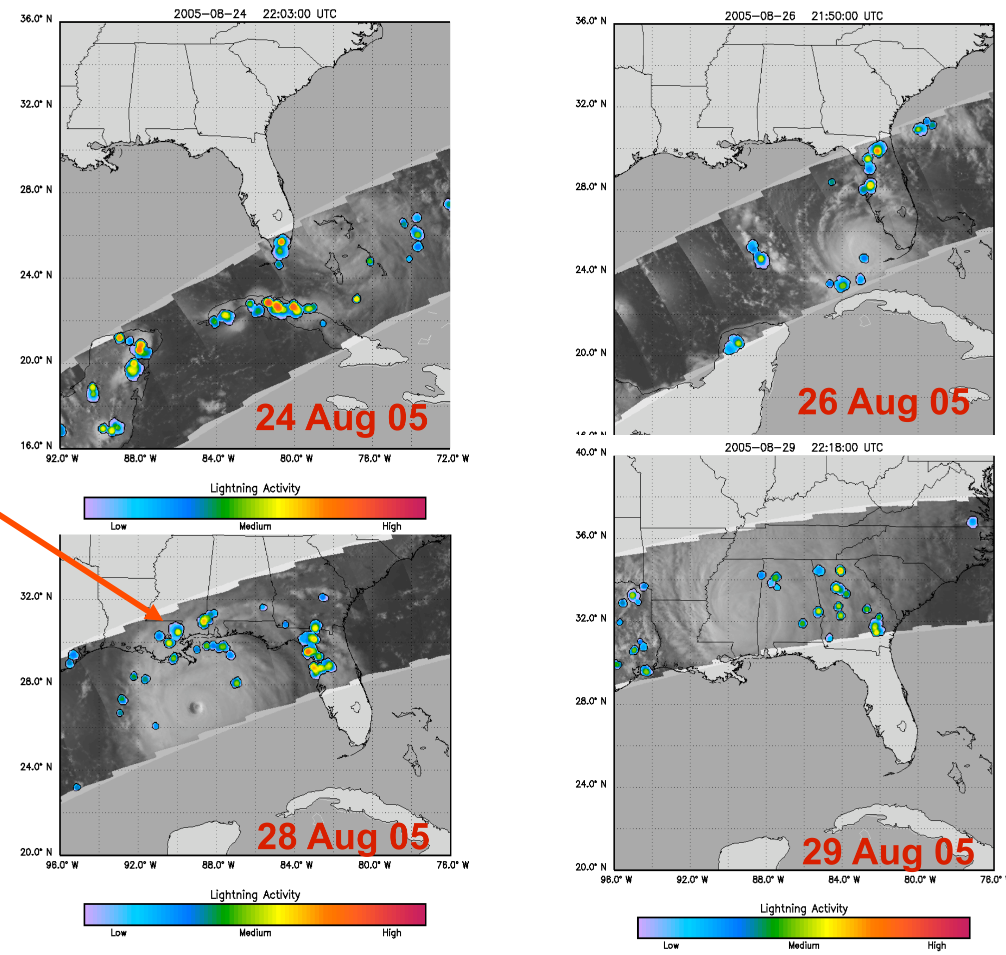
ABI proxy imagery and products and pseudo GLM data will be disseminated to selected WFOs (early 2010) and to the PG testbed as part of the Hazardous Weather Testbed (HWT) and 2010 NSSL Spring Program

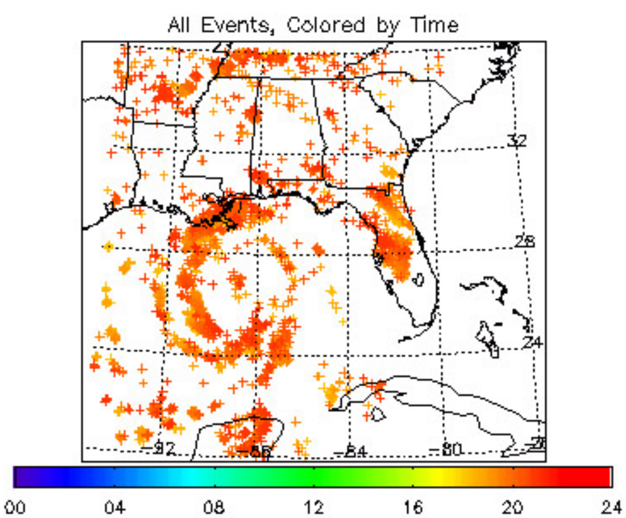
- focus on displays in AWIPS II where products can be better displayed
- preliminary product list focuses on current forecast problems

Hurricane Katrina: Lightning Imaging Sensor (LIS)

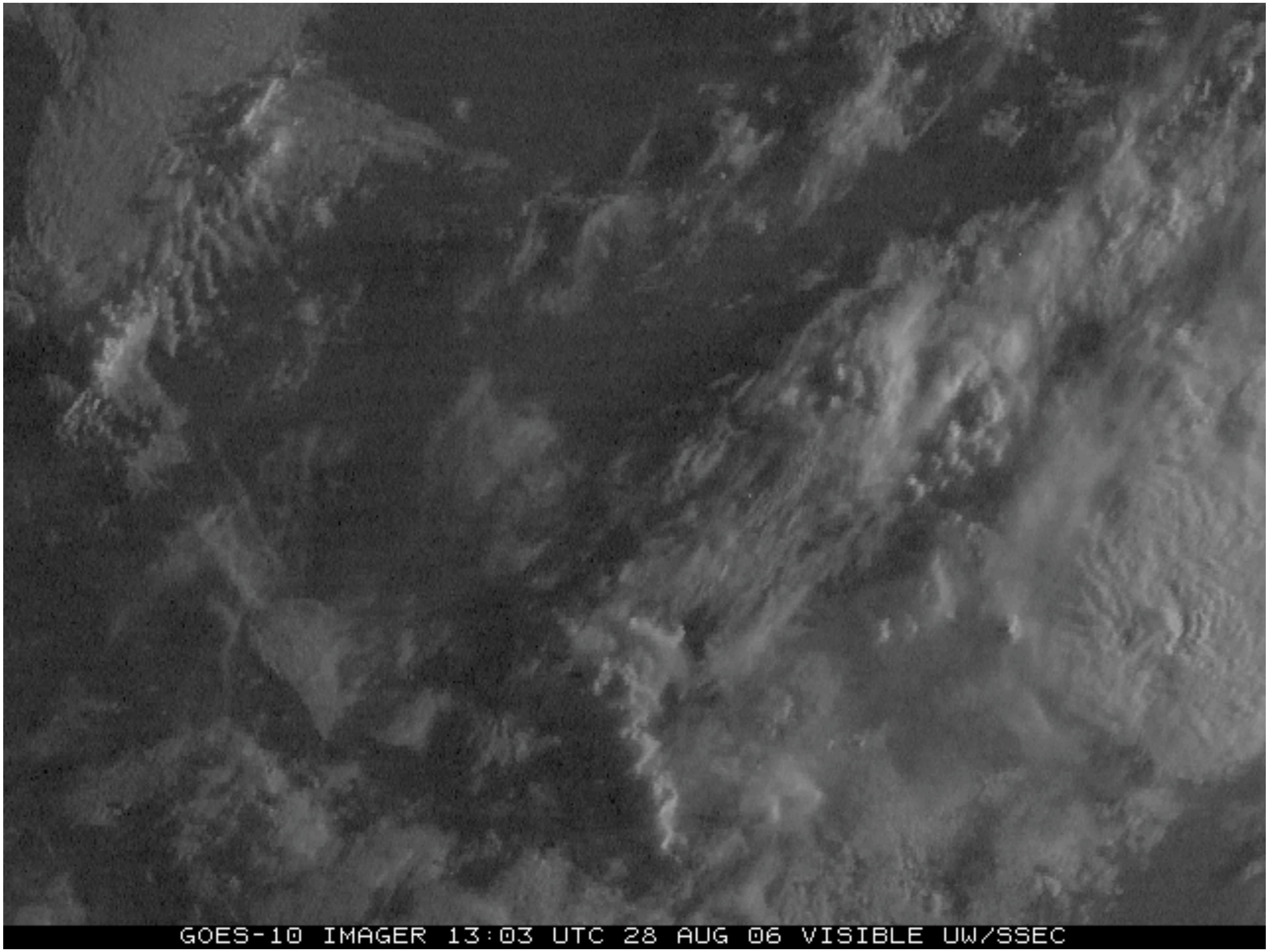
How does lightning activity vary as TC/Hurricane undergoes intensity change? Is there a useful predictor?

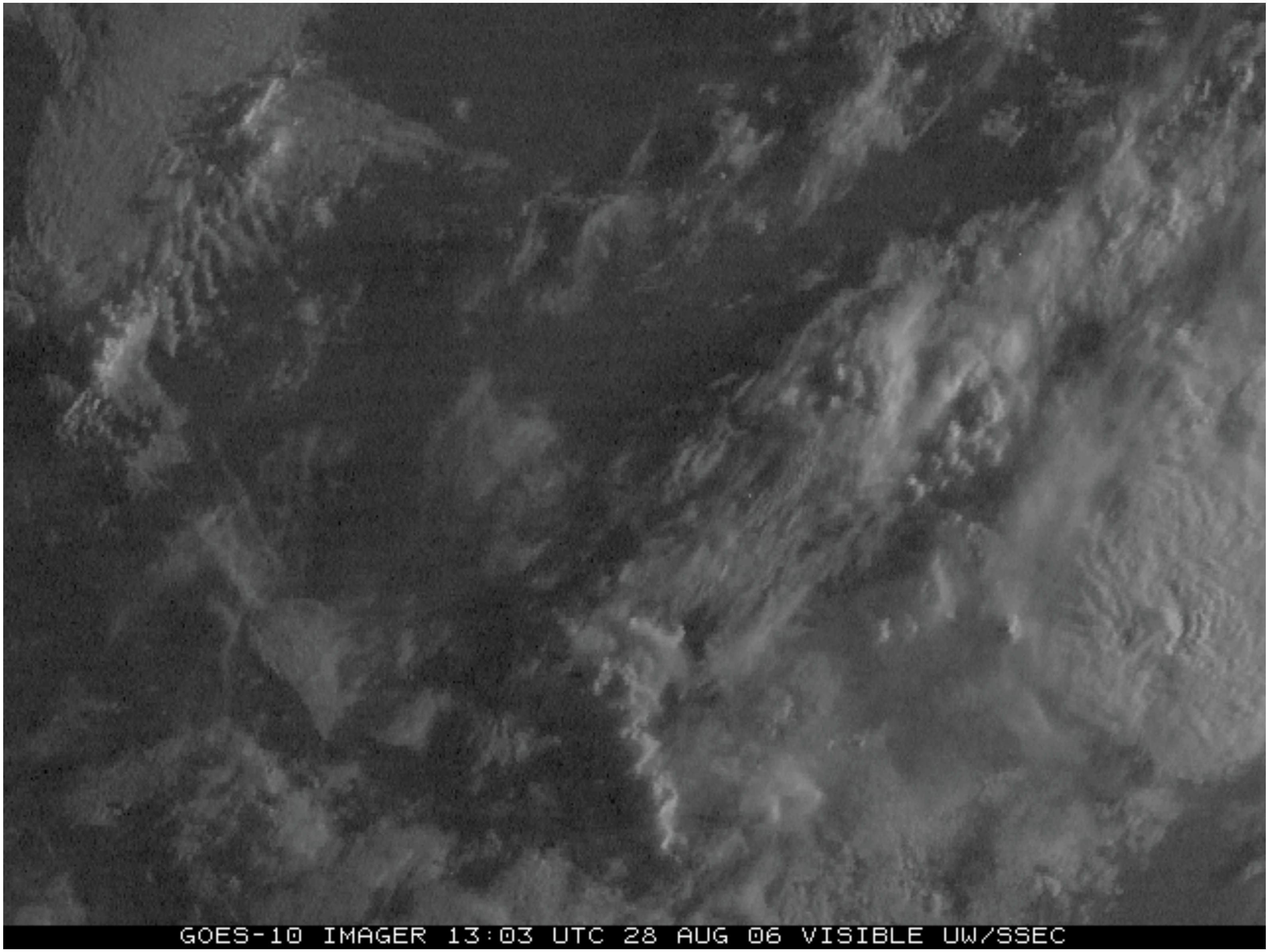
LIS Background Images
read out once per min
4 km ifov @ 777.4 nm
Orbit swath 600 km





Los Alamos Sferics Array, August 28, 2005, Shao et al., EOS Trans., 86


GOES-10 IMAGER 13:03 UTC 28 AUG 06 VISIBLE UW/SSEC


GOES-10 IMAGER 13:03 UTC 28 AUG 06 VISIBLE UW/SSEC

WRF-based Lightning Forecasts

Improve guidance on lightning threat (1-24h) using high resolution WRF runs that adequately represent storm microphysics

- use two proxy fields from explicitly simulated convection:
  - graupel flux near -15 C (captures LTG time variability)
  - vertically integrated ice (captures LTG threat area)
- simulate flash rate density and calibrated to match LMA observations

- each threat calibrated to yield accurate quantitative peak flash rate densities
- both threat fields are highly correlated in space – can combine the two

ABI imagery and GLM data will provide unique observations for nowcasting and lightning warning. WRF-based lightning forecasts provide guidance on precursor favorable regions for lightning activity.

Summary

- The GOES-R Proving Ground is critical to mission success
- Program Plan Published
- Phase I spin-up at CIMSS, CIRA (2008)
- Phase II added SPoRT, AQ, Alaska, Pacific
  - HWT IOP with VORTEX-2 (2010)
- Need real time and archived events (AWIPS2, WES)
- PG is the ultimate tool for user interaction
- Must maintain focus on clear path to operations
- Ensuring pathway into operations by developing GOES-R proxy products for the AWIPS2 environment
- Existing and Planned collaborations with NOAA Testbeds- HWT, JHT, DTC, HMT